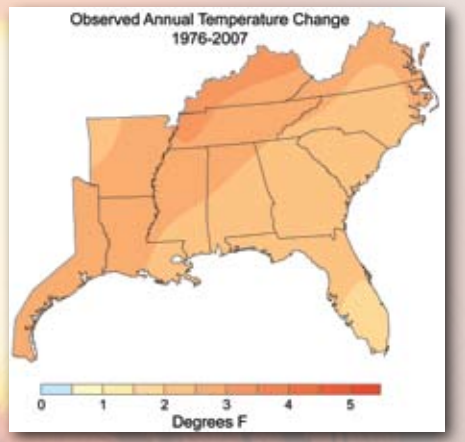
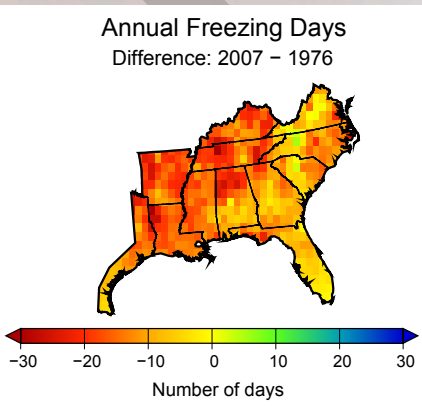
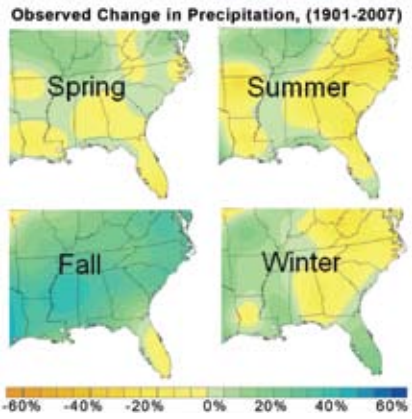
Southeast



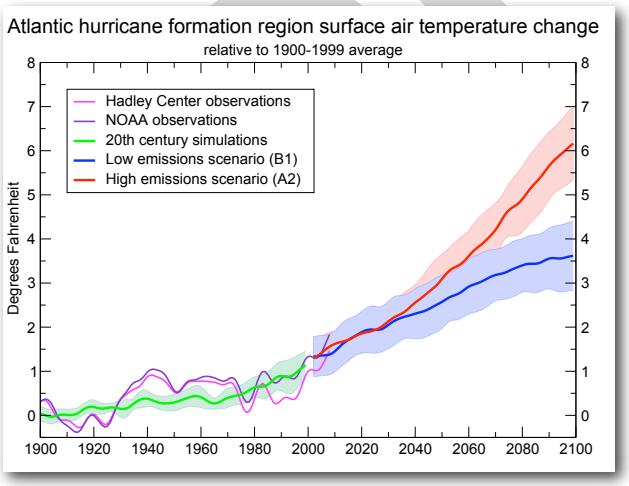
The climate of the Southeast is uniquely warm and wet, with mild winters and high humidity, compared with the rest of the continental U.S. The annual average temperature in the Southeast rose about 2°F between 1970 and 2007, with the greatest increase occurring during the winter months. The number of freezing days declined by 4 to 7 days for most of the region since the mid-1970's. Average fall precipitation increased by 30 percent for the southeastern region since 1901. The decline in fall precipitation in South Florida contrasts strongly with the regional average. There has been an increase in heavy downpours in many parts of the region[1,2] while the percentage of the region experiencing moderate to severe drought increased over the past three decades. The area of moderate to severe spring and summer drought increased by 12 percent and 14 percent, respectively, since the mid-1970s. Even in the fall months, when precipitation tended to increase in most of the region, the extent of drought increased by 9 percent.

Climate models project continued warming in all seasons across the Southeast and an increase in the rate of warming through the end of this century. The projected rates of warming are more than double those experienced in the Southeast since 1975, with the greatest temperature increases projected to occur in the summer months. The number of very hot days is projected to rise at a greater rate than the average temperature. Under a lower emissions scenario, average temperatures in the region are projected to rise by about 4.5°F by the 2080s, while a higher emissions scenario yields about 9°F of average warming (with about a 10.5°F increase in summer, and a much higher heat index). Rainfall is projected to decline in South Florida during this century. Climate models provide divergent results for future precipitation for the remainder of the Southeast, though they suggest that the upper tier of states in the region will tend to receive more annual rainfall than the Gulf Coast. Because higher temperatures lead to more evaporation of moisture from soils and water loss from plants, moisture deficits and droughts are likely to continue to increase.





An increase in the intensity of hurricanes is likely to accompany global warming as a function of higher sea surface temperatures, which have been observed globally, including in the Atlantic hurricane formation region. A measure of hurricane power based on intensity, duration, and frequency has risen over recent decades in the North Atlantic, correlated with rising sea surface temperature[3,4,5,6,7]. An increase in average summer wave heights along the U.S. Atlantic coastline since 1975 has also been attributed to a progressive increase in hurricane power[8]. Future temperature projections for the ocean region where Atlantic hurricanes form suggest that the warming observed during the past century may double by 2030[8a]

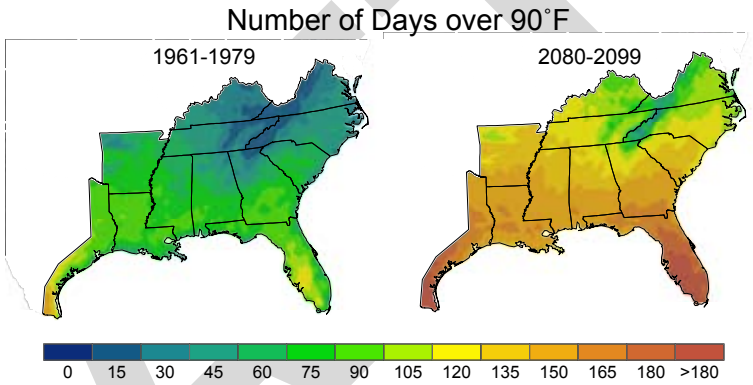


Projected increases in air and water temperatures will cause heat-related stresses.

The warming projected for the Southeast during the next 50 to 100 years will create heat-related stress for people, agricultural crops, livestock, trees, transportation and other infrastructure, fish, and wildlife. The average temperature change is not as important for all of these sectors and natural systems as the projected increase in maximum and minimum temperatures. Examples of potential impacts include:

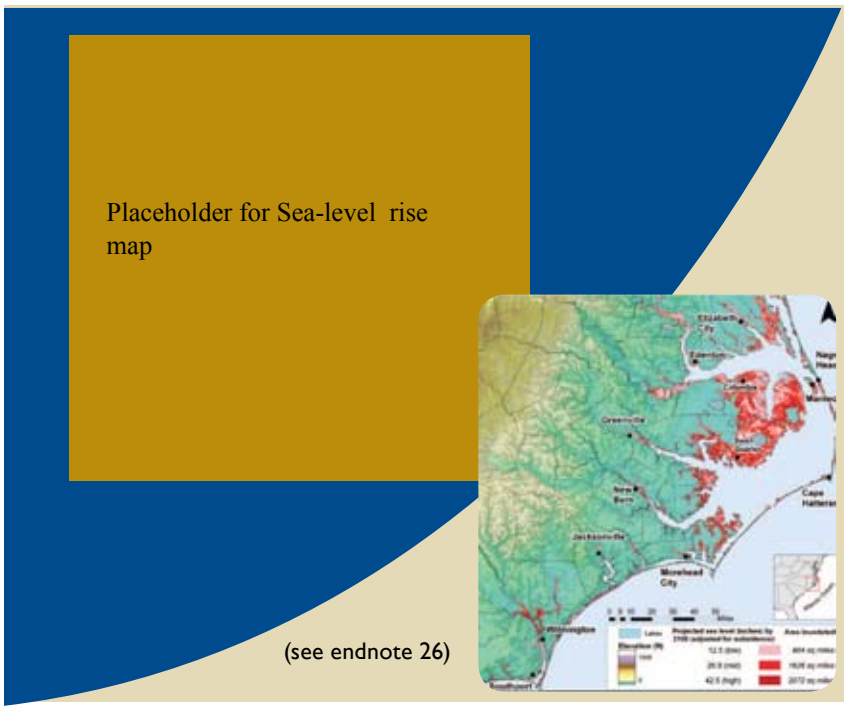
- Widespread illness and loss of life due to increased summer heat stress[9].
- Decline in forest growth and agricultural crop production due to the combined effects of thermal stress and declining soil moisture[10].
- Buckling of pavement and railways[11,12].
- Decline in dissolved oxygen in stream, lakes, and shallow aquatic habitats leading to fish kills and loss of aquatic species diversity.
- Decline in production of cattle, poultry, and other livestock[12a]. Significant impacts on beef cattle occur at continuous temperatures in the 90-100°F range, increasing in danger as the humidity level increases (see *Agriculture* sector)[13].

A reduction in the number of days below freezing is likely to reduce the loss of human life due to cold-related stress, but the number of cold-related deaths is generally much lower than the percentage due to heat stress[14,15]. Effects of the projected increases in temperature include more frequent outbreaks of shellfish-borne diseases in coastal waters, altered distribution of native plants and animals, elimination of many threatened and endangered species, displacement of native species by invasive species, and more frequent and intense wildfires.



Decreased water availability will impact the economy as well as natural systems.

Decreased water availability due to increased temperature (which increases moisture lost to evaporation and plant water loss to the atmosphere), and increased societal demand will very likely affect many sectors of the southeastern economy. The hydrology of natural systems is also affected by both climate change, and human response strategies such as an increase in storage capacity (dams) and an increase in acreage of irrigated cropland[16]. The 2007 water shortage in the Atlanta region created serious conflicts between three states, the U.S. Army Corps of Engineers (which operates the dam at Lake Lanier), and the U.S. Fish and Wildlife Service, which is charged with protecting endangered species. Streamflow and biological diversity can be reduced or eliminated as humans seek to adapt to climate change by manipulating water resources[17]. During droughts, recharge of groundwater will decline as the temperature and spacing between rainfall events increases as projected. An increase in groundwater pumping will deplete aquifers and place increasing strains on surface water resources. Increasing evaporation and plant water loss rates alter the balance of runoff and groundwater recharge and is likely to result in saltwater intrusion into shallow aquifers in many parts of the Southeast[17].



Accelerated sea-level rise and increased tropical storm intensity will have serious impacts.

The accelerating rate of sea-level rise and the likelihood of increased hurricane intensity are among the most costly consequences of climate change, due in large part to the concentration of development in the coastal zone. As sea level rises, coastal shorelines will retreat, and low-lying areas will be inundated more frequently, if not permanently, by the advancing sea. As temperature increases and rainfall patterns change, soil moisture and runoff to the coast are likely to be altered. The salinity of estuaries, coastal wetlands, and tidal rivers will likely increase in the southeastern coastal zone, thereby restructuring coastal ecosystems and displacing them further inland. More frequent storm surge flooding and permanent inundation of coastal ecosystems and communities is likely in some low-lying areas, particularly along the Central Gulf coast where the land surface is sinking[18, 20]. A rapid acceleration in the rate of increase in sea-level rise could potentially threaten a large portion of the Southeastern coastal zone. The likelihood of a catastrophic increase in the rate of sea-level rise is dependent upon ice sheet response to warming, which is the subject of much scientific uncertainty[19].

An increase in hurricane intensity would adversely affect low-lying coastal ecosystems and coastal communities along the Gulf and South Atlantic coastal margin. An increase in intensity has implications for runoff, river flooding, and coastal erosion. Strong hurricanes also pose a severe risk to people and personal property, public infrastructure, and coastal ecosystems in the Southeast, and this risk will likely be exacerbated[18, 20]. Hurricanes have their greatest impact at the coastal margin where they make landfall, causing storm surge, severe beach erosion, inland flooding, and wind-related casualties for both cultural and natural resources. Recent examples of our vulnerability to severe hurricanes include Katrina and Rita in 2005, which were responsible for the loss of more than 1800 lives and the net loss of 217 square miles of low-lying coastal marshes and barrier islands in South Louisiana[10,21].


Fish processing plant

Ecological thresholds are likely to be crossed, causing the rapid restructuring of ecosystems and the services they provide.

Ecological systems provide numerous important services that have high economic and cultural value in the Southeastern region. Ecological effects cascade among both living and physical systems, as illustrated in the following examples of ecological disturbances that result in "non-linear" responses, as opposed to a gradual and proportional response to warming:

- the sudden (as in a major hurricane) loss of coastal landforms that serve as a storm surge barrier for natural resources and communities[10, 22].
- an increase in sea level with no apparent effect until an elevation is reached that allows widespread, rapid salt water intrusion into coastal forests and fresh water aquifers[23].
- lower soil moisture, higher temperature, and higher fuel loads due to CO_2 enrichment, that lead to intense wildfires or pest outbreaks (such as the southern pine beetle) in southeastern forests[24], intense droughts that lead to the drying of lakes, ponds, and wetlands, and the local or global extinction of riparian and aquatic species[17].
- a initial increase followed by a precipitous decline of wetland-dependent coastal fish and shellfish populations due to the rapid loss of coastal marsh[25].

Quality of life will be affected by increasing heat stress, water scarcity, and severe weather events, and reduced availability of insurance for at-risk properties.

Over the past century, the southeastern "sunbelt" has attracted people, industry, and investment. The population of Florida more than doubled in size during the past three decades, and growth rates in most other southeastern states were in the range of 45 to 75 percent concentrated in coastal counties. Future population growth and the quality of life for existing residents is likely to be affected by the many challenges associated with climate change, such as reduced insurance availability, and increases in water scarcity, sea-level rise, extreme weather events, and heat stress.